

International Conference on Bioenergy Utilization and Environment Protection
6th LAMNET Workshop – Dalian, China 2003

Bioenergy from Sugar Sorghum in Xinjiang

Wang Zhaomu / Li Shoushan
Xinjiang Academia of Agricultural Sciences
38 Nachang Road, 830000Urumqi, Xinjiang, China
Email: xaasy@xaas.ac.cn, lss@xaas.ac.cn
Internet: www.xaas.ac.cn

Sugar sorghum is characterized by drought resistance, water-logging resistance, salt-alkali tolerance, rapid growth, high yield and wide range of uses. Sugar sorghum is a C₄ crop with high energy, low compensation level of carbon dioxide and high efficiency of photosynthesis. Especially in regions with distinct day-night temperature difference, and longer sunshine duration, sugar sorghum has large accumulative photosynthesis, low consumption of respiration, high accumulation of sugar and high potential for increasing the yield. According to the domestic and international experiences of production and processing sugar sorghum, and the climate condition and current research achievements in Xinjiang, it has become one of the main strategic measures for Xinjiang to vigorously develop the industry of sugar sorghum so as to adjust industrial structures, to optimise crops structure, to promote the industrialization of regenerative energy crops and to improve the living conditions of farmers.

1. The Advantages of Developing Sugar Sorghum Production in Xinjiang

1) Abundant resources of sunshine and heat

The basic climatic requirements for growing sugar sorghum is that the annual accumulated temperature above 10°C should reach 3000 to 4000°C. Annual accumulated temperatures above 10°C in Hotan Prefecture of southern Xinjiang, Tacheng Prefecture of northern Xinjiang, Turpan Prefecture of eastern Xinjiang and Kashgar Prefecture of western Xinjiang are 4443.9°C, 3081.0°C, 5443.2°C and 4271.9°C, respectively. Therefore, sugar sorghum can be grown in most places of Xinjiang. As the frost-free period can reach 160-240 days in the whole South Xinjiang and parts of North Xinjiang, especially in East Xinjiang, even the latest maturing variety of sugar sorghum can be mature. Annual radiation value in Xinjiang is 130-155 kcal/cm². The effective radiation energy for photosynthesis is decreasing from south to north of Xinjiang, generally 60 to 75 kcal/cm² per year, about 5 to 10 kcal/cm² per year more than that of East China, South China and the Middle & Lower Reaches of Yellow River. Xinjiang is one of the regions in China with the longest sunshine duration. Annual sunshine duration in Xinjiang can reach 2550 to 3500 hours and annual percentage of sunshine is 60 – 80 %. The abundant sunshine and heat resource in Xinjiang favours growing short-day plant, and it is also very good for the nutrition growth of sugar sorghum.

2) Plentiful water and land resource

Xinjiang is located in northwest of China, the central part of Eurasia. Total land area of Xinjiang is 1660.4 thousand square kilometers, about 2.419 billion mu (1 ha = 15 mu), accounting for one sixth of China's total territory. Xinjiang has small population and large land area and the land resource in Xinjiang is very rich. The land area suitable to cultivation accounts for 7.8 percent of the total area of useable wasteland.

Xinjiang is far from the ocean, where the climate is arid and annual rainfall is very low with only about 150 millimeters. However, Xinjiang has much snow in high mountain areas and surface run-off as well as underground run-off, which has high potential to be exploited. The development of oasis agriculture in Xinjiang is mainly dependent on irrigation, which is suitable to grow many kinds of crops.

2. The foundation of research achievements for developing sugar sorghum in Xinjiang

1) Richness of sugar sorghum varieties

The Xinjiang Academy of Agricultural Sciences (XAAS) has 12 local sugar sorghum varieties, 3 new varieties with intellectual property, 50 hopeful and reserve strains and 15 good varieties introduced from domestic and international sources. According to different uses of sugar sorghum, efforts should be made to introduce domestic and international excellent varieties of sorghum, suitable to Xinjiang's condition, so as to accelerate the industrialization course of sugar sorghum.

2) Maturing cultivation techniques for growing sugar sorghum

The cultivation techniques for growing sugar sorghum have been maturing in Xinjiang and China. The relevant research organizations and production enterprises have accumulated and summarized the successful production experiences in terms of sowing pattern, planting density, disease and pest control, irrigation and fertilizer management and machinery harvest. These techniques are reliable technological supports for Xinjiang producing sugar sorghum in large area by machinery.

3) Powerful research ability of sci-tech

XAAS and other research organizations can provide technological support to develop sugar sorghum industry in Xinjiang. XAAS has rich experiences and powerful research ability in breeding, judging technique of introduction and cultivation technique. The institute of Turpan of XAAS has been engaging in research of sugar sorghum for more than 30 years, and already bred 5 sorghum varieties and 3 sugar sorghum varieties. Now, the extension area of sugar sorghum is more than 150 thousand mu.

4) Good foundation for technological cooperation

The Institute of Botany of China Academy of Sciences (CAS), and Beijing Green Energy Institute of Cash Crop have already made many advanced achievements in the research field of sugar sorghum, which is leading in the world. They have already bred many new varieties, and summarized a set of cultivation techniques, and applied a compound feed patent of sugar sorghum straw powder and published book and thesis collection on sugar sorghum. Moreover, they have already established a social system of technological service. XAAS already established a good cooperative relationship with the Beijing Green Energy Institute of Cash Crop in introducing excellent varieties and the patent achievement of processing techniques.

5) Comparison of component analysis and feeding experiment between sugar sorghum and maize

The comparative results of active component analysis between sugar sorghum and maize show that:

- a) In all the eleven indicators analysed, seven indicators of sugar sorghum are better than those of maize, while other 4 indicators of maize are better than those of sugar sorghum;
- b) In all the 9 kinds of active microelements analysed, sugar sorghum has higher content than maize in 5 kinds of microelements, while maize has higher content in other 4 kinds;
- c) In all the 17 kinds of active components of amino acid analysed, sugar sorghum has the same content as maize in 3 kinds, and other 12 indicators of maize are better than sugar sorghum.

A feeding experiment was conducted in 2002 in Manasi County. Sugar sorghum harvested with a plant area of 133 hectares can be used to feed 1333 cows in one year. While normal silage maize with the same plant area can only be used to feed 1000 cows in one year. The demonstration and extension results have shown that sugar sorghum in Xinjiang has many advantages, such as good quality, higher content of sugar, good palatability, high nutrition value, strong adaptability and easy management. All these prove that extension of sugar sorghum in Xinjiang has a fine prospect.

6) The implementation plan

An implementation plan has been made according to the research report on industrialization of sugar sorghum in south Xinjiang. The plan stressed that the industrialization must be driven by the leading dragonhead enterprise and animal husbandry industry. In the next 3 years, follow targets will be achieved:

- a) Excellent varieties of sugar sorghum will be vigorously extended, and the extension area will be expanded to 1200 thousand mu;
- b) Through researching on cultivation technique of higher yield, the new rules of cultivation technique of yield 10 ton/mu will be summarized and designed;
- c) The production output of silage feed will reach 2500 thousand tons, the production of straw powder will reach 600 thousand tons and the production of compound feed will reach 3000 thousand tons;
- d) The production output of white spirit over 55-degree will reach 96 thousand tons and accordingly the production of ethyl alcohol will reach 48 thousand tons.

Furthermore, following targets will be achieved before 2010:

The plant area of sugar sorghum is expected to expand to 2000 thousand mu, 3 processing factories are to be established, which can annually produce 900 thousand tons of straw powder and process 4500 thousand tons of compound feed;

To meet the rapidly growing demand of feed in South Xinjiang, the annual production of silage feed will reach 4000 thousand tons, and an enterprise will be established to annually produce 300 thousand tons of fuel ethyl. According to the developing plan above-mentioned, the plant area of sugar sorghum must reach 2000 thousand mu at least, so as to meet the material demand from industrialization.

XAAS has already done much research on sugar sorghum for developing industrialization of sugar sorghum, and already laid a solid foundation for promoting the development of sugar sorghum industry.

3. Benefit analysis of sugar sorghum in Xinjiang

1) Benefit analysis of silage sugar sorghum

A sample analysis was conducted in Manasi County, where the frost-free period is 157 days and annual accumulated temperature above 10°C is 3563.9°C. In 2001, the demonstration area was 15 mu and the experiment results shown that the plant height is 3.8 to 4.0 meters, and average biological mass production is 6.9 ton/mu. In 2002, the demonstration area was expanded to 2000 mu and the plant number is 10600, the average stem height is 3.76 meters, stem diameter is 3.89 centimeters, average sugar content is 16.1 percent, and the yield is 5000 to 8850 kg/mu. If calculated with 7000kg/mu of the average yield and 0.105 yuan/kg of the straw price, the net benefit will reach 485 yuan/mu after a deduction of 250 yuan/mu of all production cost, i.e. seeds, fertilizer, irrigation, machinery and tax. Because the average yield of sugar sorghum is more than 7 ton/mu, production of sugar sorghum with 3 mu can meet the feed demand of two cows in one year. Clearly, production of sugar sorghum can provide sufficient and good quality silage feed for developing animal husbandry.

2) Benefit analysis of producing compound feed of straw powder

If the yield of fresh silage is 7.5 tons /mu, and the purchase price of factory is 0.12 yuan/kg, then following benefits can be obtained:

Farmer's benefits: farmer can gain 900 yuan /mu from selling fresh silage, and gain net benefit of 600 yuan/mu after deduction of the production cost of 300 yuan/mu.

Factory's benefit: supposed that 100 kg straw can be processed into 28 kg powder, then the powder output will be 2.1tons/mu and the price of powder is 1 yuan/kg. Therefore, factory can gain benefit of 2100 yuan/mu and gain net benefit of 850 yuan/mu after deduction of material cost of 900 yuan/mu and other cost of 350 yuan/mu, including depreciation, labour, water and electricity, coal, tax and management fee.

Then, the total net benefit of farmer and factory will be 1450 yuan/mu. If we consider the factory can further produce white spirit and ethyl alcohol with sugar sorghum, the benefit will be much larger.

3) The economic analysis of sugar sorghum and maize

It is planned to expand the accumulated plant area of sugar sorghum to 1200 thousand mu in 3 years.

Sugar sorghum of 500 thousand mu will serve as silage feed and the farmers can gain 300 million yuan;

Sugar sorghum of 500 thousand mu will serve as compound feed of straw powder and farmers and factories can benefit 725 million yuan;

Sugar sorghum of 200 thousand mu will serve as ethyl alcohol and the net benefit will be 360 million yuan;

The total benefit of sugar sorghum with a plant area of 1200 thousand mu, will be 13850 million yuan.

In 2001, the plant area of maize in Xinjiang was 6154.5 thousand mu, the total production is 2938 thousand tons, and average yield is 477 kg/mu. The production value of maize will be 477 yuan/mu, if the maize price is 1 yuan/kg. The net benefit will be 297 yuan/mu after deduct the production cost of 150 yuan/mu. Thus, the total net benefit of maize with plant area of 1200 thousand mu, will be 35.64 million yuan. Accordingly, the benefit of sugar sorghum is 2.88 times the benefit of maize.

The analysis results clearly show that the incremental benefit will increase by 102.86 million yuan if the crop structure is adjusted the sugar sorghum material is further processed. Obviously, the development of sugar sorghum industry will bring huge economic benefit and it should be vigorously promoted in Xinjiang.

Development of sugar sorghum industry not only can bring economic benefit, but also huge ecological and social benefit. Burning of fuel alcohol only produces little waste gas, non-poisonous and with little smell, so as to greatly reduce air pollution. Fuel ethyl also can replace part of gasoline when gasoline is mixed with a certain amount of fuel ethyl, which will have no influence on car performance, but will benefit environmental protection. Therefore, development prospects of sugar sorghum in Xinjiang is very hopeful, also it is a necessary shortcut for Xinjiang's farmers to alleviate poverty and to improve their living conditions.